A man reads, or sees in a public hall, that two electrified pith-balls attract or repel each other. He learns that the human body may be charged with electricity. Straightway he begins, upon this basis, to explain the table-tipping feats of spiritualistic mediums, — a gross error, hardly more respectable than the pure superstitition of the veriest believer in ghosts.

To make such errors impossible would require that definite, familiar knowledge of things, in their quantitative relations, which is hardly to be obtained without actual contact. It would require a laboratory training; and it is perhaps impossible to make provision for a very extended training of this sort in any scheme of general education.

The tendency of the times, however, is toward the objective and experimental in teaching; and it is probable that the next few years will see considerable changes in the methods of general instruction in physics.

WHIRLWINDS, CYCLONES, AND TORNADOES.[1] — III.

WE may now pass on from the small daytime whirls of dry air to the larger, long-enduring storms that are accompanied by rain; and here will be met two new elements, — the effect of condensing vapor, and the effect of the earth's rotation, — both of great importance. As a sample under this second heading, we may take one of the cyclones of the Bay of Bengal; for the storms there are very characteristic of their class, and have of late years received much careful attention. There is good reason for thinking that these cyclones generally spring up in calms, much as the desert-whirls begin. The seasons and regions of their occurrence both point to that conclusion; for tropical cyclones seem never to begin in well-established wind-currents, but rather in a place of quiet, weak, or variable winds. By India, for example, the cyclones are almost unknown during the prevalence of the steady blowing monsoons, but are not uncommon at those seasons when the monsoons change; that is, at times when the air has no well-established motion, but stands about idly, waiting for a decisive command to move on. During these idle times of stagnation, the lower air may become very warm and moist, and so prepare for a stormy overturning. The calm that precedes a cyclone often makes part of the description of a storm at sea: the air is close and oppressively warm; the water settles down to a glassy surface; and now we may see, what is not always clearly expressed, that this calmness of the water, and oppressive heat of the air, are not antecedent effects of the coming storm, but are actually the conditions that allow and determine the beginning of a storm. The warmer the air and the quieter the water, the longer must have been the preparatory stage; the greater the quantity of solar force collected in the lower atmosphere, the more violent will be the storm when it begins. This warm calm is really the embryo of the cyclone; and, if it lie long enough in a proper latitude, it will grow to well-developed maturity.

It is often stated that tropical oceanic cyclones begin at the meeting of two opposite currents of air rather than at a time of calm. This may be true for some cases, and undoubtedly has a very general application in temperate latitudes; but it seems more probable that in the Bengal cyclones, and most other tropical hurricanes, this stage is a little later than the earliest beginning, and is really the first development of the inblowing winds. A general calm would doubtless be found to precede such opposed currents if observation could trace the antecedent conditions a little farther back than is usually possible. The principal contrasts between the desert-whirls and the Bengal cyclones, at the time of their beginning, may be thus summarized: —

First, The area and uniformity of the surface on which the disturbance is developed is much greater on the ocean than on the desert.

Second, There is a lower temperature, but a much greater amount of heat, surface for surface, in the cyclone's embryo, than in the whirlwind's. The temperature of the air over the ocean seldom exceeds 95°: over the desert sands it may often rise to 140° or 150° close to the ground. But on the desert the stratum of air that is so excessively warmed is very thin; it often fails to reach the height of a man's eye, and so gives the appearance of a mirage: while over the sea, although the lower stratum is not so warm, its thickness is greater, and there is more of it warmed. What it lacks in temperature it more than makes up in quantity.

Third, The presence of water-vapor over the ocean makes a most important contrast between the two cases; and it is on this account that the warm sea-air is cooler than the hot desert-

[1] Continued from No. 40.

air. Water-vapor is not nearly so diathermous as dry air. Much of the heat that would pass down to the sand on the desert is held back by the vapor over the ocean, and some is caught again from the heat radiated upwards by the water, so that a considerable thickness of air is warmed. Of still more importance is the vapor's action as a great storehouse of solar force, required in the process of its evaporation, generally known as 'latent heat.' For all these reasons, the accumulation of energy in the preparation for an oceanic cyclone is vastly greater than in the making ready for a desert-whirl.

(*To be continued.*)

REMARKS UPON THE OSTEOLOGY OF PHALACROCORAX BICRISTATUS.

IT is a fortunate thing for science, that time allowed many of our Alaskan explorers to bring back in their collections, and to the museums, skeletons of so many of the rarer forms of the vertebrates, particularly the birds of those unfrequented regions. To Dr. T. H. Bean and Mr. H. W. Elliott, both of the Smithsonian institution, we are under lasting obligations for such material, and for making so good use of their advantages. The writer has enjoyed the unusual privilege of examining and studying long series of skeletons of Lobipes hyperboreus, Haematopus niger, rare forms of Rissa, Larus, and Sterna, many of the auks, puffins, and the like, — nearly all from the source that I have mentioned.

It was during the course of my examination of these sub-arctic rarities that my attention was called to several points of interest in a set of skeletons, representing three young and an old one, of a species of cormorant, Phalacrocorax bicristatus, forming part of the collection of the last-named naturalist. Professor Owen, in the second volume of his 'Comparative anatomy and physiology of vertebrates,' on p. 64, speaks of a bony style that is attached to the occiput in the cormorant as one of the cranial peculiarities of the class. This author does not mention its use; and as the writer has not a cormorant before him intact, with all the soft parts, it would be hardly safe to give its exact function in this bird's economy: but as I do not believe we have a figure showing the site of this bonelet, an illustration of the skull of Phalacrocorax is here given, showing, life-size, the right lateral view. This prominent style is seen protruding from the summit of the occiput in my drawing, not as a spinous outgrowth from that point, but rather as a free bone, concave below, separated into two concavities on its superior aspect by a sharp median crest that is developed on its entire length, — a transverse elliptical facet anteriorly, that articulates freely with a corresponding one on the occiput.

At the base of the cranium, we find that the pterygoids are completely overshadowed by the sub-compressed but rather large brain-case above. There are no basi-sphenoidal processes thrown out to meet these bones. The posterior halves of the palatines form a close union all along their median and inner margins, which portions are much spread out horizontally. Beyond, they become narrower; and in the space that we find existing between them we observe a long attenuated vomer, terminating anteriorly in a free, pointed extremity. The cormorants belong to the Dysporomorphae of Professor Huxley's classification; and he and other eminent anatomists have given other cranial characteristics in their descriptions of this well-defined group. The rami of the lower mandible are deeply grooved on the inner aspects of the dentary portion; and these elements, originally free, retain their sutures, distinctly marked, through life, where they join the other interested segments at the posterior moiety. Seventeen vertebrae are found in the cervical region, before we arrive at one that bears a free pair of ribs. Of this

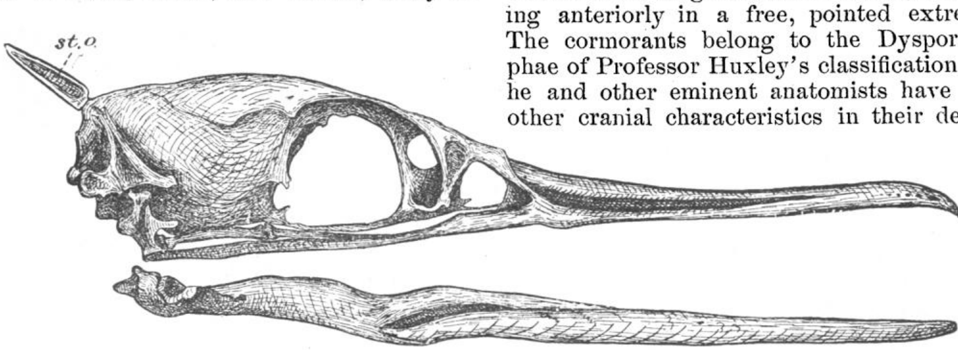

FIG. 1. — Skull of Phalacrocorax bicristatus, life size; right lateral view, showing occipital style, *st. o.*